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ECONOMICS OF MANAGING SPECIAL TOOLING AND SPECIAL TEST EQUIPMENT

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A specialized as well as costly task of the Air Force has been its use of special tooling and special test equipment (ST/STE). Basic to the effective management of ST/STE is the ability to accurately establish its value. This thesis presents an indepth analysis of the costs and benefits of retaining ST/STE for the F-100 and F-105 defense systems during the FY 69 - FY 71 time period. In order to assess the value of ST/STE, both fiscal and non-fiscal elements were included in the study. In addition, the importance of utilizing an automated system as a management tool was examined.

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THE ECONOMICS OF MANAGING SPECIAL
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THE ECONOMICS OF MANAGING SPECIAL TOOLING AND SPECIAL TEST EQUIPMENT

A Thesis

Presented to the Faculty of the School of Systems and Logistics

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

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THE STUDY

The Problem

In the procurement of defense systems and support equipment, the contractor must fabricate or acquire test equipment, tools, jigs, fixtures, and similar items needed for production. This type of tooling and equipment is known as special tooling and special test equipment (ST/STE), the cost of which is included in the contract price paid by the government. Upon completion of the contract, a determination must be made on the disposition of these items. The Air Force may elect to retain title to the test equipment or obtain title to the special tooling. If this action is taken, the contractor is then directed to hold this ST/STE in his facilities or transfer it to a government-owned storage area. If no future value is foreseen for the tooling or equipment, it is sold as tooling and test equipment, or sold for scrap. The proceeds of these sales are placed back into the program from which the funds were originally obtained. If the program has been disbanded, the proceeds are returned to the U. S. Treasury. Between these extremes lie many alternative courses of action. The problem is to determine which course of action to take considering the cost versus the benefits

obtained through the retention of tooling. Great strides have been made toward improving controls over the disposition of this type of equipment during the past two years. However, proper disposition and control is not yet being effected under present procedures. Management of these items is very expensive and may exceed the benefit derived from their retention.

Background

The level of manufacturing technology for modern systems is rising dramatically. New methods of manufacture and the tooling required to perform these operations are evolving continually. (19:v) The tooling and equipment required by these technological advances has come to be known as Special Tooling and Special Test Equipment. As distinguished from the other classes of government-owned equipment, special tooling is defined in the Armed Services Procurement Regulation

> as all jigs, dies, fixtures, molds, patterns, taps, gauges, other equipment and manufacturing aids, and replacement thereof, which are of such a specialized nature that, without substantial modification or alteration, their use is limited to the development or production of particular supplies or parts thereof, or the performance of particular services. (5:13-101.5)

Special test equipment means

> electrical, electronic, hydraulic, pneumatic, mechanical or other items or assemblies of equipment, which are of such a specialized nature that, without modification or alteration, the use of such items (if they are to be used separately) or assemblies is limited to testing in the development or production of particular supplies or parts thereof, or in the performance of particular services. (5:13-101.6)

Many employees in the Department of Defense mistakenly interchange the terms "Special Test Equipment (STE)" and "Aerospace Ground Equipment (AGE)." Therefore, it is necessary to make a distinction between STE and AGE in order to avoid confusion. Although STE and AGE can appear to be identical, Aerospace Ground Equipment is listed under a federal stock number whereas Special Test Equipment is not classified under such a number. AGE provides the Air Force with a base/depot repair capability, while STE is required by technical engineers during production. This thesis deals with special tooling and special test equipment. It will not deal with aerospace ground equipment.

The volume and value of ST/STE in the Air Force inventory fluctuates in response to national and international affairs. However, this total is always sizeable as indicated by the current inventory. Presently it is estimated that the volume of ST/STE in the Air Force Logistics Command totals 286,000 pieces at a dollar value in excess of $165 million. (22) This equipment is dispersed throughout the country in many locations, some of the large storage areas being the Boeing Company in Seattle, Washington holding $41 million worth of tooling, the Autonetics Division of North American Rockwell in Anaheim, California holding $13.8 million worth of tooling, and Griffiss AFB in Rome, New York holding $5.5 million worth of tooling. (22)

The control of this inventory is a sizeable and expensive task. Although extensive tooling lists are held in

various Air Force organizations, these lists have a tendency to become as obsolete as the equipment they reflect. Better controls and management systems are needed to help reduce inventory levels when appropriate.

Special Tooling and Special Test Equipment items generally enter the inventory in the following manner. When a prime procurement contract nears completion, the Procuring Contracting Officer (PCO) is provided with a list of all ST/STE acquired by the production contractor. The list is then forwarded to the Administrative Contracting Officer (ACO) who has 180 days to screen the list and decide which items must be retained by the Air Force. Generally this list is forwarded to the Air Materiel Area (AMA) in Air Force Logistics Command which will manage the system. The System Manager of the new defense system, with the assistance of item managers, then indicates the tooling which may be needed for future procurement in support of the system. This information is forwarded to the PCO who in turn informs the contractor of the government's decision on each of the items.

It is very difficult to make an accurate prediction of future usage requirements for this type of equipment. The System Manager has access to a classified Life of Type program in which the life expectancy of the weapon system is portrayed. If this information is insufficient, the Operations Branch of the System Manager can go through the Operating Division of Air Force Logistics Command for a query to the Chief of Staff of the Air Force. However, even this

detailed guidance seldomly can predict unexpected changes in mission requirements in later years of a weapon system. Consequently, some ST/STE is retained which is never used again and some which could be utilized at a later date is salvaged. In the case of the F-84 aircraft for example, the government sold some of the tooling to the contractor in 1965, not expecting any future use for the items. Through a mix-up in the records, this tooling was listed as government-owned and available for use on an Invitation for Bids for material on the F-84 in 1969. (12)

The process of reviewing these tooling and equipment lists is very time-consuming and expensive. The tooling list generated by the production of the F-111 A, B, C, and D models totaled 198,271 items. This list had to be screened within the 180 days required by regulation. (8) Finding a storage area for such a quantity of equipment in a short time frame can pose problems. This problem, though not in the scope of the current study, is mentioned to give the reader an appreciation of some of the complexities of special tooling.

The topic of government furnished equipment has generated great controversy since its inception at the beginning of World War II. Government policy has continually stated the preference that contractors furnish their own equipment. However, the reluctance of the contractor to invest in some specialized types of equipment has forced the Government to purchase its own tooling and equipment in many contracts. In these instances the contractor is wary of

purchasing equipment that may be useful in only one contract. Many knowledgeable personnel in the tooling field believe it is more expensive for the contractor to purchase and retain title to ST/STE than for the Government to perform this function. If the contracting officer cannot guarantee future procurements utilizing the equipment, the contractor will attempt to amortize the complete price of the tooling less salvage value in the contract. Consequently, the Air Force pays for the tooling anyway without the benefit of its use as government-owned property in future procurements.

Since 1967, the Air Force has come under considerable criticism from its own auditors and the General Accounting Office on the management of ST/STE. (3) In many instances, only inadequate records have been available on the location of the equipment and its disposition status. The claim has been levied by many contractors that the presence of this equipment in the initial producer's plant provides him with an unfair advantage and restricts competition. If another contractor desires to use government-owned tooling, he must pay shipping charges to his plant and determine how to adapt the tooling to the equipment in his plant. As a result of such claims and GAO recommendations, the Armed Services Procurement Committee has established a policy through the Armed Services Procurement Regulations that tooling and equipment must be maintained in such a way as to provide a competitive environment.

After years of debate on the problem of government-owned facilities, Assistant Secretary of Defense for Installations and Logistics, Barry J. Shillito sent a memo to the Army, Navy, and Air Force on 4 March 1970 on the phase-out of government-owned facilities and plant equipment. The memo requires contractors to submit plans for phase-out of such equipment over a five-year period. (11:53) This policy, though covering a broad range of government-owned equipment, does not include ST/STE. However, it gives a good indication of the attitude the present administration has toward government-owned equipment.

To date, research in the field of special tooling and special test equipment has been inadequate. Bibliographies reviewed from the Defense Documentation Center at Cameron Station, Alexandria, Virginia and the Defense Logistics Studies Information Exchange at Fort Lee, Virginia indicate that research has been conducted on several of the facets of special tooling/test equipment. However, very little has been recorded on the cost effectiveness of maintaining the special tooling/special test equipment inventory in the Air Force. Past research has been thwarted because of the impossibility of acquiring data reflecting benefit to the Air Force. A computerized system now enables us to compare the costs of maintaining this inventory with some of the benefits received.

Automation of ST/STE Management

The manual procedures utilized into the 1960's became ineffective and cumbersome as the workload increased with

each new acquisition. As a result, the Special Tooling/Test Equipment Management System (CO 17) was developed at the Sacramento Air Materiel Area (SMAMA) to meet the need for better inventory control. CO 17 is a computerized system designed to maintain an accurate record of the location and status of all ST/STE acquired by SMAMA. It helps to direct management action on the inventory.

The CO 17 system "provides for the acquisition, control, property accounting, reuse and disposition of government-owned special tooling and special test equipment, exclusive of industrial plant equipment." (20:13-5) However, the identification of special tooling and special test equipment poses a unique problem. In making an identification, the part number must not only give information on the detail assembly that the tool fabricates, but also the next higher and major component of the assembly.

The contractor is required to give only the tool number that he has assigned to the tool, the part number that the tool makes, and a functional description of the tool. In order to get the tool properly classified into the federal system, the system manager or item manager must interrogate the Defense Logistics Services Center (DLSC) provisioning data bank to obtain a federal stock number for all contractor furnished part numbers.

Through the use of a coding procedure developed in the CO 17 system, a rapid identification of all tools and equipment in the inventory can be achieved. If the only

information available is the federal stock number, or perhaps only the tool number, the computer is able to identify the entire assembly the tool helps to fabricate. Now for the first time in tool inventory management, it is possible to obtain the relationship a tool has with other tools that are utilized in fabricating a component of an assembly.

Scope

This study was limited to systems supported by the Material Utilization Control Office at the Sacramento Air Materiel Area (SMAMA). This office employs the CO 17 automated system in managing ST/STE. SMAMA was chosen over the other Air Materiel Areas (AMA's) because it is the only AMA using an automated system to control ST/STE. The system has been operational for a sufficient period (two years) to provide information on the cost of operation to the government. This period has been adequate to identify some of the benefits received by the Air Force. The major benefits include:

1. ST/STE inventory levels have been reduced to the minimum required for projected procurements. The Sacramento Air Materiel Area has reduced its inventory level from 279,729 items of ST/STE when the CO 17 started to a current level of 50,104 pieces. (18) A portion of this reduction was realized through yearly decreases in the inventory level and cannot be credited to the CO 17.

2. When a procurement is projected for the future, the system can immediately determine if ST/STE is available.

3. A more accurate record is kept on the location of tooling.

In order to gain a better perspective on utilization rates when tooling and equipment were available to a contractor,

the study was limited to all transactions dealing with the F-100 and F-105 weapon systems. These aircraft have been in the field 17 and 12 years respectively.

A thorough analysis was undertaken on the major costs incurred and the benefits derived in managing ST/STE for each weapon system during fiscal years 1969, 1970, and 1971. The results of the study of these two systems were used in projecting recommendations on the disposition of ST/STE on future defense systems.

Objective

The objective of this research effort was to determine the cost effectiveness of managing the Air Force inventory of special tooling and special test equipment.

Research Question

The following research question was addressed in this study: Is it economical for the Air Force to maintain an inventory of special tooling and special test equipment on its defense systems?

Chapter 2

PROCEDURE

Approach

A logical way of determining the economic plausibility of any operation is to perform a cost/benefit analysis. This is accomplished by comparing total costs incurred with total benefits derived. This thesis provides such an analysis.

Ideally, this study would encompass ST/STE in all Air Force defense systems and would span the entire life cycle of costs and benefits. Initial acquisition costs of the ST/STE should be excluded because they are sunk costs and therefore irrelevant. Sunk costs are defined as those which have already been incurred and thus should have no bearing on present or future decisions. This is due to the fact that the money is spent and will remain so, regardless of the decision made. (10:391)

Time restrictions precluded the study of all Air Force defense systems. The F-100 and F-105 systems were chosen because they are both managed by one Air Materiel Area, the Sacramento AMA. The two systems comprise 80% of the ST/STE managed at SMAMA. Another advantage of studying these particular systems is that they have been in the Air Force

inventory long enough to depict almost an entire life cycle of a defense system. Results gained from such a study can be used in aiding ST/STE management on future defense systems.

The study was limited to the time span of FY 69 through FY 71 because this was the only period in which adequate data were available. Statistical induction over the life of the ST/STE was infeasible due to the incomplete, nonrandom, and erratic nature of the data.

Ideally, such a study as this should--for the sake of precision, credibility, and exhaustiveness--identify the accountant's elements of cost. That is, it should dissect costs into elements such as fixed and variable; direct labor, direct materials, and overhead; and explicit and implicit cost. However, such actual break-outs were not available and any attempt to hypothesize or obtain them by inductive reasoning would have resulted in a much less precise product than did the approach used.

In summary, the approach employed was that of considering all available costs and benefits involved in the management of ST/STE for the F-100 and F-105 systems during the period FY 69 through FY 71.

The Formula

Basically, a cost/benefit analysis consists of totalling all relevant costs, totalling all relevant benefits, and subtracting one total from the other. The remainder is net benefit or net cost (depending upon which is larger). If

total benefits exceed total costs, then costs are subtracted from benefits and the remainder is net benefit. If costs exceed benefits, then benefits are subtracted from costs and the remainder is net cost. If the result is net benefit, the operation under analysis can be considered economical. If the result is net cost, then the operation can be considered uneconomical and therefore should be discontinued or curtailed. There are certain cost or benefit elements which are non-fiscal, e.g., contribution to the national defense. Such elements do not fit into a mathematical formula and thus must be given special treatment as will be illustrated.

In this study, all possible elements of cost and benefit involved in the management of F-100 and F-105 ST/STE were considered. After consideration of all possible aspects of the situation, the following elements were included in the cost/benefit analysis formula. Each element is followed by an abbreviation or mathematical shorthand in parentheses. Benefit elements are: tooling avoidance (TAB), and salvage value (SVB). Cost elements are: electronic data processing equipment operation including personnel and equipment (SOC), transportation (TTC), storage (STC), and opportunity (OPC).

The formula:

Net Benefit = (TAB+SVB) - (SOC+TTC+STC+OPC)

Benefit Elements Explained

Tooling Avoidance (TAB)

This element consisted of the current value of all F-100 and F-105 ST/STE used on government contracts during

the relevant period. The data provided were the <u>actual</u> costs of the ST/STE at the time of acquisition. Prices had increased dramatically by FY 69-FY 71 and the Air Force would have had to pay FY 69-FY 71 prices had it not had the ST/STE on hand. In other words, it was the cost of tooling at FY 69-FY 71 prices which the Air Force was actually avoiding. Consequently, an inflation factor was added for each year between initial acquisition and the middle of the relevant period.

<u>Salvage Value (SVB)</u>

The estimated life of the ST/STE was determined for both systems. Then the realizable scrap value at the end of this life was calculated using the current disposal figures on the F-104 system. The present value of this figure was then taken in order that salvage value could be presented in the same base period as the other benefit and costs.

<u>Cost Elements Explained</u>

<u>Electronic Data Processing Equipment (SOC)</u>

This cost element consisted of computer software development, hardware maintenance, and operating costs. The automated system was still in the developmental stages during this period and some significant developmental costs were incurred. Data system development costs diminished as maintenance costs increased throughout the period.

<u>Transportation (TTC)</u>

This element included <u>actual</u> freight rates applied to an <u>estimate</u> of the total volume of ST/STE shipped between

storage and using contractor. The underlying assumption here was that the government paid the transportation costs whenever items were shipped to or from a firm for use in the performance of an Air Force contract. Whereas the government was not always directly charged for such transportation, it was believed that the government always ultimately bore such costs through mark-ups in the concurrent contract or some subsequent contract(s). This also encompasses costs actually incurred in shipping ST/STE for government purposes only. For instance, when the F-100 ST/STE was relocated from El Segundo, California to Palmdale, the government paid the cost of preparation and shipment.

Storage (STC)

Included here were the actual costs incurred at the two main storage sites--Palmdale, CA (F-100) and Griffiss AFB, NY (F-105). The Palmdale site was contractor-operated and the Griffiss site was government-operated. The Palmdale costs included in the cost/benefit analysis formula were solely the contract prices paid over the three years of the study. The Griffiss costs consisted of estimates of operating costs of the storage site.

Opportunity (OPC)

Opportunity cost is defined as a fruitful opportunity not taken, i.e., a money-making alternative not chosen. (10: 388) In this case it is the amount of money foregone by not selling the ST/STE during the period of this study. It is the cost of not obtaining the money that could be realized

through the sale of the ST/STE. Had the tooling been sold at this time, the proceeds could have been used in another manner, i.e., investment in other government projects. The fact that the Government did not generate revenue from the sale of these items is the opportunity cost of not employing this money elsewhere.

Non-Fiscal Elements

There are certain elements which have an impact on the economy of managing ST/STE and to which dollars and cents cannot be assigned. These elements substantially affect the value of managing ST/STE but their exact effects cannot be quantitatively measured. Therefore, the existence of such elements was merely noted and conclusions drawn as to their influence on the final analysis. The conclusions were based on an evaluation of the elements which consisted of a census of expert opinions.

Had the census of qualitative elements been in agreement with the outcome of the quantitative equation, the role of those elements would have been purely supportive. If the qualitative elements had disagreed with the quantitative equation or with each other, this paper would have drawn conclusions based on the judgements of the writers. The reader can do the same, based upon his own relative weights assigned to the elements.

The qualitative elements were: competition enhancement, equal treatment to all potential bidders, mechanization,

and contribution to national industrial mobilization and national defense.

The Director of Procurement and Production at each of the AMA's was asked four questions: (1) "Do you think that government-furnished ST/STE significantly enhances competition? Answer yes or no." (2) "Do you think that government-furnished ST/STE significantly promotes equal treatment to all potential bidders? Answer yes or no." (3) "Do you think that it is advantageous for the Government to operate a mechanized ST/STE control system? Answer yes or no." (4) "Do you think that government-furnished ST/STE contributes significantly to national industrial mobilization or national defense? Answer yes or no."

Elements Excluded

1. Initial acquisition costs of the ST/STE were omitted for reasons given earlier in this chapter: they were considered to be sunk costs.

2. Depreciation costs were excluded because they are paper cost only and contribute nothing to a cost/benefit analysis.

3. Computer amortization cost was excluded due to the narrow time period and the limited scope of the study. If the scope of the study had been expanded to include total life and all-comprehensive costs, amortization in anticipation of equipment replacement would have to have been considered. However, this study would have benefited very little

from such a consideration.

4. Reduction of end item inventory. End item as used here means components, parts, and materials which become part of the aircraft (as opposed to the ST/STE which is used to produce those end items).

There are certain end items which are repetitive requirements. If the Government did not maintain the ST/STE necessary to produce those end items, that ST/STE would have to be acquired upon each recurrence of need. Lead time for the end item would thus be extended. It follows then that end items in stock (including items intransit in the supply channel) would have to be increased.

The reason for excluding this element of benefit was that it was believed to be relatively insignificant. The great majority of end items are required very infrequently. This benefit is not applicable to non-repetitive items. If there is no measurable recurring demand, there is no stock level maintained and consequently, no continuous flow of goods through the supply channel. If there is no stock level and no goods in the supply channel, there is no inventory to be reduced. The predominance of the remaining items require very little lead time and thus little potential for savings.

5. Solicitation costs. The administrative costs incurred in making ST/STE available in Invitations for Bid (IFB's) and Requests for Proposal (RFP's) are very insignificant. Availability data are automatically provided to the procurement function by the CO 17 system. Costs of this

service are nevertheless charged as system maintenance for the CO 17.

However, in the process of offering ST/STE, problems do develop which incur additional costs. The procurement office at SMAMA offers these items on an "as is, where is" basis. The prospective bidders are encouraged to inspect the tooling and satisfy themselves that it is suitable for their use. Occasionally, a bidder is unable to find the tooling or notes that it is broken and cannot be used. If such an event occurs before bid or proposal opening, supplementary paperwork is generated which has been estimated to cost the Government an additional $100 per solicitation. If such a problem develops after opening of a solicitation or award of a contract, the cost incurred varies greatly and is impossible to predict with any accuracy. This element was considered insignificant because it occurs infrequently and is therefore excluded from the analysis.

6. <u>Contract Price Reduction Benefit</u>. The Government generally realizes lower contract prices when ST/STE is offered. One method of determining the magnitude of this advantage is through the use of a dual bid procedure. A dual bid is one in which the contractor is asked to quote a price with the use of government-owned tooling and test equipment and another price without the use of this tooling and equipment. Records indicate that dual bids were solicited on 23 line items during the 1968-1969 period. A separate contract award was made on each of the items. In this dual bid test,

18 of the 23 line items obtained lower prices in return for the use of government-owned ST/STE as compared to the prices submitted if the tooling had not been available. On three of the items, the price was the same with or without tooling, while on two of the 23 items, no contractor would submit a bid without the use of government-owned tooling. Had tooling not been available in these two instances, an award could not have been made. This limited test reflects that ST/STE does have a value to the Government and in certain instances is invaluable to mission accomplishment.

In determining the difference in cost to the Government on the basis of availability of ST/STE, a bid price without tooling was considered for all line items except the two instances in which no contractor would bid without tooling. These differences totaled:

Table 1

A Comparison of Contract Prices
With and Without Government-Furnished ST/STE

Without ST/STE	$277,236.17
With ST/STE	244,997.69
Difference	$ 32,238.48
These figures yield:	$\frac{32,238}{244,998} = 13.2\%$

This indicates that the Government saves 13.2% or over 13¢ on the dollar when special tooling and special test equipment is used.

Since the value of this element is, in effect, already included in the Tooling Avoidance (TAB) element, it would be redundant to include the contract price reduction benefit in the analysis. The TAB element has included the acquisition value of all ST/STE utilized, plus an allowance for inflation. The results of an indepth dual bid test would have been preferable to the Future Tooling Avoidance element developed in this paper because such an approach would reveal the true cost savings of ST/STE. However, the test cited in this section was considered too limited to be representative of all ST/STE utilization between FY 69 and FY 71.

7. Inventory reduction benefit. The inventory of ST/STE is screened annually for items which should be considered for disposal. The general rule of thumb is that items not having been utilized within the previous three year period are disposed of. In addition, the inventory is screened on special occasions such as mass relocation. The F-100 inventory was reduced from approximately 45,000 line items (LI) to about 22,000 LI just prior to and in conjunction with the move from El Segundo to Palmdale. The F-105 inventory was reduced from roughly 42,000 LI to approximately 20,000 LI just prior to and in conjunction with the move from the three locations in New York and Kansas to Griffiss AFB.

Costs were saved on many aspects of the ST/STE operation, e.g., computer operation, LI research, transportation, etc. However, the only savings of significance were on storage cost. Savings of storage costs are accounted for in the

use of <u>actual</u> storage cost information in the STC element. Therefore, this element was excluded as a separate element.

<u>Nature and Sources of Data Received</u>

The data received are precisely described in the next chapter; however, the final section of this chapter deals with the general sources and nature of those data.

The preponderance of data were received from the Materiel Utilization Control Office (MUCO), SMAMA. Unless otherwise noted, any data presented in this study has been received from MUCO. This data was received in a great variety of formats, which was understandable in view of the fact that it had not been generated for the purpose of this study. Notwithstanding its general nature, it provided a substantial data base from which the skeletal structure was formed.

After receiving all data from the MUCO office, a considerable amount of analysis remained. Aid in this analysis was generally secured by seeking information by telephone from various sources such as: HQ AFLC; OOAMA; AFPRO, Culver City, CA; NAVPRO, Burbank, CA; the Director of Procurement and Production at each AMA; and others.

Chapter 3

DATA ANALYSIS

In this chapter, each element in the Cost/Benefit Analysis Model is developed. The exact quantity for each element is presented with a short formulation and background. In elements where an extreme amount of calculations were required, the computations are provided in the Appendix.

The elements of the model which include,

Net Benefit = (TAB+SVB) - (SOC+TTC+STC+OPC)

will be presented in the following order:

TAB - Tooling Avoidance
SVB - Salvage Value
SOC - Electronic Data Processing Equipment
TTC - Transportation Costs
STC - Storage Costs
OPC - Opportunity Costs

Tooling Avoidance

The availability of special tooling and special test equipment in producing components for a system eliminates the need to retool for production. Provided the necessary tooling and equipment are available, many substantial costs are eliminated. Included in these are the basic re-engineering and retooling costs.

Cost Savings Data Adjustment

In this study, the quantity and value of tooling re-utilization were determined for each system. Then a deter-

mination was made that, had these items of ST/STE not been available for use by the contractor, a minimum of the initial acquisition cost for the tooling plus an allowance for inflation would have been incurred by the Government. These items have increased in value since their original acquisition because material and labor prices have increased significantly. It is reasonable to assume that in some instances tremendous re-engineering and retooling costs would have been incurred. These costs would be greater now because it is more difficult and costly to design a tool after initial production has been completed. Because of the additional costs incurred in constructing a tool from technical drawings, it is reasoned that the costs of retooling after completion of the contract probably would have run much higher than the costs presented in this study; however, in order to keep from over-inflating the re-utilization benefit of ST/STE, these potential cost savings were excluded.

In order to allow for tool value appreciation, an adjustment for inflation has been developed using the manufactured goods listing of the Wholesale Price Index. Although this index does not account for all the factors influencing the change in price of the ST/STE since initial acquisition, it does provide a conservative estimate of the price increase.

Cost Savings Data

Cost and usage data were not quite complete on either the F-100 or the F-105 systems for the FY 69-71 period. When these data were incomplete because of the lack of records,

figures were projected based on past history of the systems and are considered sufficiently accurate for the purposes of this study. The rates of utilization and the value of the ST/STE used during FY 69-71 are:

Table 2

Utilization Rate and Value of ST/STE

F-100		
Year	Number of Items	Adjusted Value
FY 1969	1191	$709,339
FY 1970	856	693,422
FY 1971	277	154,068
Total	2324	$1,556,829

F-105		
Year	Number of Items	Adjusted Value
FY 1969	3832	$1,915,573
FY 1970	765	510,883
FY 1971	1316	1,068,698
Total	5913	$3,495,154

Development of these values is described in Appendix A. These values will be inserted into the basic formula presented in this study.

Salvage Value

Salvage value is a key element in determining potential benefits to the Government in the retention of special tooling and special test equipment. Machine tools and test equipment in most cases can realize a monetary benefit when

sold on the open market. The amount of resale value depends on the foreseeable future usage requirements, the age of the tooling and equipment, its condition, and the value of the metal and components in the items.

If the ST/STE is sold immediately after completion of the initial production run, it will command a higher price on the market than if it is sold ten or fifteen years later. Bidders would be inclined to pay more for the equipment at this time because the expectation of re-utilization is very high early in the life cycle of the system. However, as the system ages, the value of the ST/STE quickly drops to a price equal to the scrap value of the metal and components alone. Past sales indicate that over 91% of the items of ST/STE sell on the market for an average of $1.05 per tool.

Sales Potential

If the Government had decided to sell every item of F-100 and F-105 ST/STE during this study, it is estimated that the following dollar values would have been realized from such a sale.

Table 3

Salvage Value

	F-100[1]	
Year	Quantity of ST/STE	Salvage Value
FY 1969	47,222	$323,578
FY 1970	46,616	319,432
FY 1971	21,799	149,251

[1]See Appendix B for computations.

Table 3 (Continued)

Year	F-105 Quantity of ST/STE	Salvage Value
FY 1969	35,651	$244,379
FY 1970	35,651	244,379
FY 1971	19,801	135,646

However, it must be realized that salvage value and opportunity cost cannot be calculated on the same base period. An opportunity cost is incurred when the ST/STE is not salvaged and conversely, is not relevant when the tooling undergoes disposal action. The ST/STE was not salvaged during this period, therefore it was assumed that the tooling would be scrapped at the end of the life of the defense system, between 1974 and 1976. Next, it was necessary to take the present value of this final disposal figure so that all costs would be based during the time period of this study. It was also assumed that the inventories would not experience any more drastic reductions. The CO 17 has stabilized the inventory size.

Since all proceeds for the sale of Air Force owned ST/STE are returned to the General Fund of the U. S. Treasury, this money is lost to the Air Force for all practical purposes. Before realizing the sale of ST/STE as a great benefit to the Air Force, it is necessary to address the problem of disposing of this equipment.

Cost of Disposal

The preparation for sale, and the actual sale of ST/STE is a very expensive proposition. An indication of this can be seen at the Lockheed plant in Burbank, California. The contractor has submitted a bill to the Government for $510,000 for screening and generating a list of 10,000 items of F-104 ST/STE. When the charges incurred by the Government in selling these items are added to this total, the cost of selling each item can easily exceed the $51 per tool charged by the contractor in this case.

With the cost of disposing of ST/STE being so high, it was decided to enter a figure of zero as the benefit of salvaging ST/STE. Experts in the disposal area are of the opinion that at best, the Government only breaks even on the sale of these items. In some cases the Government has elected to abandon ST/STE in-place rather than incur the costs of disposal.

The lead and kirksite tooling is perhaps the only tooling that yields enough profit to merit a disposal effort. Past sales indicate an average return of $142 per item is realized. Since the quantity of lead and kirksite tooling is estimated to be less than 4% of the total ST/STE in a system, sales revenue from this type of tooling could be very limited.

CO 17 System Operating Costs

Description

The CO 17 system is an automated system designed to manage the inventory of special tooling and special test equipment at Sacramento Air Materiel Area (SMAMA). The identification of special tooling and special test equipment presents a unique problem. These items must be identified not only to the part which they fabricate, but also to the next higher major component of that part. As the quantity of ST/STE increased with each new weapon system, it became more difficult to manage this inventory manually. Therefore the need arose for more efficient ST/STE management. The use of electronic data processing equipment was one obvious solution.

The CO 17 system has enabled SMAMA to identify the ST/STE it has in storage quickly and accurately. Each time an action involving ST/STE is initiated, the procurement division is advised of the availability of ST/STE. This information is then included in the Request for Proposal or Invitation for Bid. A potential bidder then can determine the usefulness of these items in preparing his bid.

The CO 17 system will be programmed to review utilization rates of ST/STE in the near future. This change will aid the decision maker in performing retention/disposal decisions. The capability to review tool utilization will be a sound step in advancing the management of special tooling and special test equipment.

Although past utilization is the primary management technique presently used in retention/disposal decisions, four other decision criteria are used. These criteria are employed early in the life of a system and effect the ST/STE retention decision. These include:

1. The length of time a system is expected to remain in the inventory.
2. Mobilization requirements of the system. Some items of ST/STE are retained for use only in wartime situations.
3. The ST/STE necessary to repair the crash damage an aircraft might sustain.
4. Those items of ST/STE which are retained on a contingency basis. If a component on an aircraft is similar to a part on another aircraft, the tool or piece of equipment may be used on the other defense system.

Past Procedures

The years preceding 1968 saw very little active management of the special tooling and special test equipment inventory. Lack of accurate records identifying ST/STE to the associated production item or the subsystem it produced led to very poor re-utilization rates. Some AMA's reported substantial uses of ST/STE in isolated cases; however, no effective controls assured any continuity of usage.

It is estimated that the Sacramento Air Materiel Area spent approximately $42,000 a year on the management of

special tooling and special test equipment in the years before the system was automated. This sum consisted almost entirely of wages paid to an average of five mid-range GS employees.

CO 17 Costs

The advent of the CO 17 system in 1968 gave rise to a whole new category of special tooling and special test equipment costs at SMAMA. These costs have been divided into three basic areas: development, mission, and system maintenance costs. Included in the development costs are all of the costs incurred in analyzing and programming the system. Mission costs cover personnel time spent on each developmental project entered into the CO 17. System maintenance costs include costs of debugging the system, costs of operating the system, and training costs.

In developing CO 17 system operating costs, several assumptions were made and are addressed in Appendix D. Using these assumptions, the operating costs of the CO 17 include:

Table 4

CO 17 Cost Allocated by Weapon System

	Total		System Maintenance Cost	
	F-100	F-105	F-100	F-105
Oct 68-Jun 69	$22,997	$19,366	$ 1,261	$ 1,053
Jul 69-Jun 70	33,659	28,344	4,929	4,151
Jul 70-Jun 71	27,565	23,213	10,373	8,735
Total	$84,221	$70,923	$16,563	$13,939

Total CO 17 costs for each weapon system will be considered only in matters pertaining to total costs of ST/STE management during the three year period of this study. In making projections on future operating costs, development and mission costs will be considered sunk costs and therefore excluded.

Transportation Costs

Background

The element of transportation, seemingly a hidden cost in the use of ST/STE nevertheless is an important cost factor. Late in fiscal year 1970, the Government incurred substantial shipping charges in moving F-100 ST/STE from contractor owned storage areas to government-owned storage facilities. The inventory of F-105 ST/STE was moved to government-owned facilities in the third quarter of fiscal year 1971.

Whenever special tooling or special test equipment is used by a contractor, a possibility exists that it must be transported and a shipping charge incurred. In the F-100 weapon system, competition became keen for the use of ST/STE as the war in Viet Nam developed. Consequently, transportation costs for ST/STE were incurred by successful bidders not possessing government-owned ST/STE. Until 1968, competition for the use of F-105 tooling was minimal. Up to this time the contractor storing ST/STE on this aircraft was generally successful in obtaining follow-on contracts in which tooling was used. Therefore very little shipping of ST/STE took

place for the F-105 before 1968.

However by 1968, competition for the use of ST/STE for the F-105 system had increased substantially so that tooling and test equipment for both weapon systems experienced considerable movement. Firms throughout the country began to actively bid on contracts in which ST/STE was available. Until 1971, the major portion of ST/STE was stored in the prime contractor's plant or in the plants of his subcontractors at special no-cost agreements. In most instances these subcontractors were located within several miles of the prime contractor. When ST/STE was shipped, it was generally within a 50-mile radius of the storage location. In the case of the F-105, two major subcontractors, Beech and Cessna, were located in Wichita, Kansas, some 1500 miles from the prime contractor. The ST/STE required by these subcontractors was fabricated in their facilities and experienced no movement until all F-105 ST/STE was moved to Griffiss.

By the end of fiscal year 1970, most of the F-100 tooling stored in contractors' facilities had been moved to government storage warehouses. By the end of fiscal year 1971 all of the F-105 tooling had been moved. In the case of the F-100, ST/STE was moved to a storage site at Palmdale, California, approximately 65 miles from Los Angeles. Tooling and test equipment for the F-105 was moved to Griffiss AFB, New York, approximately 275 miles from Farmingdale, New York, home of Republic Aviation. This move to government storage of ST/STE has had the obvious effect of increasing the

movement of the tooling and equipment when it is employed by a contractor. This in turn has increased the shipping charges paid by contractors for the use of the equipment. It has been assumed that ST/STE for the F-100 system had to be transported by the contractor from Palmdale only in FY 71 and that contractor transportation of F-105 tooling was not necessary from Griffiss until the fourth quarter of FY 71.

Allocated Charges

The movement of ST/STE during the period of this study has been calculated in Appendix C. Shipping charges incurred in the movement of special tooling and special test equipment total:

Table 5

Transportation Costs

F-100

Year	Government Move	Contractor Move	Total
FY 69	0	$1,048	$ 1,048
FY 70	$24,863	$ 860	$25,723
FY 71	0	$ 699	$ 699
			$27,470

F-105

Year	Government Move	Contractor Move	Total
FY 69	0	$1,422	$ 1,422
FY 70	0	$2,098	$ 2,098
FY 71	$173,098	$3,194	$176,292
			$179,812

Although the movement of ST/STE to government-owned facilities is considered a one-time cost, it is a cost that will eventually be incurred by every defense system. At some point in the life of a system, the ST/STE will most probably be moved out of the contractor's facilities.

The level of transportation charges incurred by the contractor fluctuates with the level of activity of the system itself. The charges are also related to the distance ST/STE is shipped. Although shipping over greater distances incurs higher transportation charges, these charges are not proportional to the miles shipped because of the short-long haul considerations.

Storage Costs

General

Whenever an initial acquisition contract is completed, the ST/STE generated thereunder customarily remains in the contractor's plant. Anticipation of future contracts necessitating the use of the ST/STE is the primary incentive for the firm to agree to store it. Most firms will store the ST/STE at no (storage) cost to the Government. This "no-cost" provision is the Government's incentive to permit the firm to store it. Government storage would entail: the construction of large facilities or utilization of existing ones; purchase or use of materials handling equipment; personnel to operate both facilities and equipment; and acquisition of support facilities and equipment for the personnel themselves. A

recent study conducted on the Palmdale Plant #42, Site 4 indicated that government storage would cost only half as much as contractor storage. However, in that particular case, no facility costs were attributed to government storage because the building was government-owned. Whether assessment of a facility charge would render government storage more expensive than contractor storage in this case or in general was unanswered here.

Although the Government generally pays no storage cost under no-cost storage agreements, there are certain expenses incurred by the storing firm for which it frequently requests remuneration. These services usually consist of <u>cleaning</u> the ST/STE and placing it on <u>display</u> for the inspection of potential bidders, treating with <u>preservatives</u> and <u>restoring</u> or <u>shipping</u> to the using contractors.

<u>F-100</u>

The F-100 ST/STE was stored under such an arrangement at Plant 42, Site 4, Palmdale under the provisions of Service Contract #F04606-69-C-0665. The contract provided for the Government to lease 278,156 square feet of inside space and 17,660 square feet open storage at no cost to the North American Rockwell Corporation (NAR). NAR would, in turn, provide the space for storage of F-86 and F-100 ST/STE at no (storage) cost to the Government. The F-86 ST/STE amounted to less than 5% of the combined total of F-86/F-100 in terms of weight, volume, and value. NAR was authorized to use space, as available, to store other government property in

the custody of the company under its other contracts with the Government.

The yearly amounts paid by the Government under Contract #F04606-69-C-0665 for cleaning, displaying, preserving, and shipping services were:

Table 6

Storage Costs, F-100

Fiscal Year	Dollars Thousands
69	72
70	95
71	62
Total	229

Subtracting 5% for F-86 ST/STE yields:

229 - (.05 x 229) = $219 thousand

This figure comprised the F-100 portion of the STC cost element.

F-105

In FY 69 and FY 70, the F-105 ST/STE was stored at three locations: Republic Aviation Division at Farmingdale, New York; Cessna Aircraft Company at Wichita, Kansas; and Beech Aircraft Company at Wichita, Kansas. At all three locations, cost-type contracts were the bases for storage. Each contract provided for storage, display, preservation, cleaning, and shipping. The approximate sums paid by the Government in each year were as follows:

Table 7

Storage Costs, F-105

Republic Aviation Division	-	$150 thousand
Cessna Aircraft Company	-	4 thousand
Beech Aircraft Company	-	35 thousand
Total Annual Cost	-	$189 thousand

Total two-year cost was:

2 x 189 = $378 thousand

As an economy measure, the Air Force started moving all F-105 ST/STE to Griffiss AFB, New York in late FY 70. The move was completed in mid-FY 71. The Griffiss site was wholly owned and operated by the Government and consequently, the storage and related costs dropped to $47,000 in FY 71.

Therefore, the F-105 portion of the STC element was:

378 + 47 = $425 thousand

The total F-100 and F-105 ST/STE storage costs for FY 69-FY 71 amounted to:

219 + 425 = $644,000

Opportunity cost

At the completion of the initial production contracts, the Government could have divested itself of the required ST/STE. If it had disposed of all the ST/STE at

this time, it is estimated that a return of approximately 10% of the initial acquisition cost could have been realized. Thus, if an analysis on the cost/benefit relationship of retaining ST/STE had been conducted at the completion of production, an opportunity cost of 10% of the ST/STE acquisition price properly should have been inputed into the model.

Subsequent to the decision not to dispose of the ST/STE, periodic analysis should be made concerning the future of a system's ST/STE. At the time of such an analysis, the opportunity cost of not disposing of the ST/STE must be considered. This opportunity cost is equal to the amount of money realized from the sale of the ST/STE at the point in time of the sale. However, as the system ages, the sales value of the ST/STE rapidly declines until it can be sold only for scrap. This point is generally reached three to five years into the life of the system.

Consequently, the worth of the special tooling and special test equipment at the time of this study was only scrap value. It has been determined in this study that the costs of disposing of ST/STE equal or exceed any revenues generated through its sale. Therefore, it has been assumed that no opportunity cost was incurred during the years of this study by either defense system. The <u>Opportunity Cost</u> of not disposing of the ST/STE is <u>zero</u> for both systems.

<u>Non-Fiscal Elements</u>

This study would have been incomplete had the non-fiscal elements presented earlier not been considered. In

the management of ST/STE, there exist some advantages and potential disadvantages for which no dollar value can be placed. These non-fiscal elements which have an impact on the economy of managing ST/STE include competition enhancement, equal treatment to bidders, advantages of automating the ST/STE management system, and national industrial mobilization or national defense. As may be recalled, four questions were asked the Directors of Procurement and Production at each Air Materiel Area. These questions were:

1. Does the ST/STE furnished by the Government enhance competition?
2. Does government-furnished ST/STE significantly promote equal treatment to all potential bidders?
3. Is it advantageous for the Government to operate a mechanized ST/STE control system?
4. Does government-furnished ST/STE contribute significantly to national industrial mobilization or national defense?

"Yes" responses were received to all of the questions. However, most responses were given with the attendant reservations as follows. The usual response to questions 1, 2, and 4 was, "Yes, but not all ST/STE and not under all circumstances." The usual response to number 3 was, "If you are going to retain and manage ST/STE, it should be automated."

As to questions 1, 2, and 4, it was realized that not all ST/STE was contributory; however, since the role of non-fiscal elements was supportive only (or contradictive only),

their importance lay in their general tendency and not in their internal vicissitudes.

Consequently, the value of the non-fiscal elements must be overshelmingly "yes."

Chapter 4

FINDINGS AND CONCLUSIONS

Introduction

In this chapter, the summation of the cost/benefit analysis equation and interpretation of the responses to the non-fiscal elements are discussed. In addition, conclusions are developed. Some pitfalls of research in the form of non-realistic conclusions are described.

The Quantitative Model

To refresh the reader's memory, the basic model and the inclusive elements are redefined.

NB = (TAB + SVB) - (SOC + TTC + STC + OPC)

Where:

NB = Net benefits

TAB = Tooling avoidance benefits

SVB = Salvage value benefits

SOC = EDPE operation and development costs

TTC = Transportation costs

STC = Storage costs

OPC = Opportunity costs

Inserting the values derived in the preceding chapter yields:

NB = (5,052 + 0) - (155 + 207 + 644 + 0)

NB = $4,046 (in thousands)

Therefore, based upon the above summation, the source data provided, the assumptions made, and the particular situation studied, it must be concluded that it is economical to retain and manage ST/STE for the two systems under observation.

This is not to say that there is not potential for further economy. It also does not indicate that the conclusion is an absolute truth and applies to all systems at all times.

However, it is believed that the above outcome is indeed true for most Air Force systems; that is, it is economical to manage ST/STE on most Air Force systems.

Conditions for Applicability

Notwithstanding the conclusion reached above, there are certain reservations which apply; that is, there are conditions which if not met, will not be appropriate to other similar situations. These conditions are listed and described below.

(1) Poor Management System. It is conceivable for the ST/STE management system to be inefficient as to offset any realized value resulting from retention of the ST/STE. It is believed that there were no such inefficient systems in existence in the USAF at this time. This is not to defend the people operating the system--only the capabilities of the systems as they then existed. This thesis does not address the problem of management (personnel) inefficiency; that can

be determined by performing a study such as this with personnel inefficiency as the objective.

Until recently, the management systems had been incapable of effectively managing ST/STE as evidenced by the criticisms levied by the Congress. An example is found in SMAMA Contract BOA AF 04(607)-9964 in which the contractor was paid $4,275.57 for special tooling manufactured in support of the contract. A later search of the ST/STE inventory revealed that this special tooling was available but was not identified to the Procurement Division for inclusion in the Invitation for Bids associated with that procurement. Another letter dated 27 March 70 stated that the tooling was to become Air Force property, but as of that date had not been returned to the Air Force.

This is not an isolated case. It is believed that such difficulties were directly resultant from the fact that the SMAMA ST/STE management system was not automated at that time. Of course, the huge size of the inventory at that time also contributed to the problem.

Furthermore, the preponderance of evidence suggests that automation dramatically enhances the efficiency and effectiveness of the ST/STE management process. The system operating cost (SOC) element is increased by automation (when we include development costs); however, this increase is more than offset by the benefits received therefrom.

Automation provides a much more efficient process of item search and thereby greatly improves disposal screening.

It also, in effect, makes more items available for re-utilization. Disposal increases the re-utilization <u>rate</u> by reducing the amount of inventory on hand (re-utilization rate = quantity of ST/STE used ÷ quantity of ST/STE on hand). Disposal also reduces storage, transportation, EDPE, and opportunity costs.

It is admitted that increased disposal activity increases the possibility of disposing of items which should not be disposed of, e.g., salvaging an item today which may be needed tomorrow. However, it is believed that such a possibility is not very significant and certainly not important enough to warrant the cessation of disposal activity.

Re-utilization is the most important contributing factor in the benefit element of the cost/benefit analysis equation--TAB. It follows, then, that if automation contributes so significantly to re-utilization, that it is a valuable management tool in achieving economy of operation.

(2) <u>Re-utilization</u>. There must be a sufficiently high re-utilization of the ST/STE to offset the costs attendant to retention. Each defense system's inventory of ST/STE in the Air Force has a break-even point for costs and benefits. The relative size of the re-utilization benefit causes the cost/benefit analysis equation to fluctuate as re-utilization fluctuates. If re-utilization is very low, the cost/benefit analysis equation could easily result in a <u>Net Cost</u> summation.

(3) Opportunity Cost. The opportunity cost decreases rapidly as a system grows in age. In view of the advanced ages of the F-100 and F-105 defense systems and the limited value of the ST/STE at this point in time, it is highly unlikely that, given the present level of utilization, opportunity costs have any effect on the cost/benefit equation for these systems.

(4) Storage. If the ST/STE were stored in a contractor owned and operated facility where storage costs were charged to the Government, costs would rise considerably over present levels. It is entirely possible for such a situation to result in a negative cost/benefit finding.

Other Findings

Benefits of Automation

Cost is not an accurate measure of the value of the CO 17 automated system; it is merely a measure of its expense to the organization. The real value of this system can be determined in part by the utilization of ST/STE experienced at SMAMA. The degree of management expertise each Air Materiel Area (AMA) exerts over its ST/STE inventory is partially reflected in utilization figures. However, each AMA is burdened with some ST/STE which must be retained in the inventory for wartime or emergency situations. Utilization of these items generally is zero, which drives usage rates down.

The value of the CO 17 system is reflected in the utilization rates for all the Air Materiel Areas for Fiscal

Year 71. (21:12-13) These rates include:

Table 8

ST/STE Utilization

FY 71

AMA	Total ST/STE Inventory	Items Re-utilized	Per Cent Utilization
SMAMA	52,692	3,197	6.0%
OOAMA	30,408	809	2.7%
OCAMA	125,961	601	.5%
WRAMA	81,039	140	.2%
SAAMA	11,599	0	0%

Although full credit for SMAMA's relatively high utilization cannot be given to the CO 17 system alone, this automated system has undoubtedly aided in attaining this rate. Therefore, the conclusion can be made that the automated system has helped improve ST/STE management.

Importance of Utilization

Utilization must be considered the key element in retaining ST/STE; for without utilization, the need for ST/STE diminishes. During the period of this study, ST/STE of the F-100 and F-105 systems experienced the following utilization rates:

Table 9

ST/STE Utilization by System

Year	F-100 Utilization Rate	F-105 Utilization Rate
FY 69	2.5%	10.8%
FY 70	1.8%	2.1%
FY 71	1.3%	6.6%

These rates were calculated based on tool utilization from the entire inventory of ST/STE for each system.

Many factors have played a role in the usage rates of ST/STE. Although data is not complete on the F-100 and F-105 systems, all of the experts interviewed in the ST/STE field claim that the heaviest usage of this type of equipment takes place in the first three to five years in the life of a system. During this time the system undergoes burn-in and shakedown modifications. Requirements are relatively high. As the system ages, the utilization of ST/STE drops off.

Data on the early years of the F-105 system are unavailable because it was managed at the Mobile, Alabama Air Materiel Area, which was de-activated in 1965. Records on utilization were not forwarded to SMAMA. Only an incomplete record could be pieced together on the F-100 system. An indication of ST/STE utilization early in the life of this system is indicated by the following table:

Table 10

F-100 ST/STE Utilization (18)

Year	Quantity Utilized	Acquisition Value (1954 Dollars)
April 1958 to April 1961	31,394	$15,100,514
Nov 1962	379	1,100,000
Feb 1964	636	2,000,000
FY 1965	2,882	1,386,080
FY 1966	unknown	1,186,243
FY 1967-1968	2,294	1,103,173
FY 1969	1,191	584,781
FY 1970	856	548,160
FY 1971	277	118,514
Total		$23,127,465

It must be remembered that these data are only fragmentary and incomplete. For instance, the 379 items reported in 1962 are from only one contract, but the only data available for that year. Consequently, it must be concluded that the dollar value of tool utilization on this system was much higher than the $23 million figure reflected by the data available since April of 1958.

Unforeseen political and international developments do exert great influences on the usage of ST/STE. In the case of the systems under study, the Viet Nam conflict has increased the aircraft usage rate dramatically, which in turn increased ST/STE usage. Had utilization figures been available during the entire life of both systems, ST/STE managers indicate that a noticeable increase in usage of the tooling

would have been reflected in the war build-up years of 1965 and 1966.

It is evident from the data presented, that the high utilization of ST/STE in the early years of a system does warrant its retention, at least until the system has been fully tested and reliable maintenance data obtained.

Inventory Size as a Factor

Current data on ST/STE inventory size reflect that large inventories are present at three of th five Air Materiel Areas. In the past, inventories of ST/STE have been much larger. It has just been in the past two to three years that the SMAMA inventories of ST/STE were pared drastically because of rising storage costs. The extremely low utilization rate of this inventory is immediately apparent. It has been noted that a portion of this inventory is for war readiness and is unusable in peacetime. The result is a negative effect on usage rates.

However, the majority of ST/STE is not considered in this category. Therefore, one should expect a higher utilization of the remainder of the ST/STE. It is suspected that a factor in the low ST/STE utilization is that the inventories are too large to be managed efficiently. In the past, the entire ST/STE inventory has been transferred to responsible AMA's upon completion of the initial contract. Little thought has been given toward spare parts requirements or future utilization. Consequently, usage rates were low because item identification methods could not yield timely

information. The problem of determining ST/STE location also existed. In many cases the difficulty of this task prevented the AMA from realizing utilization rates that should have been experienced.

Mobilization and War Readiness

The uncertainty of future usage requirements provides another argument for retention of ST/STE. World problems can flare up unexpectedly and result in immediate requirements for ST/STE. Unavailability of this type of production equipment could result in mission impairment. Depending on the complexity of the tool needed, lead time could run 3-9 months.

State of the Art and Obsolescence

These factors are also important in governing the ST/STE utilization. Recent developments in "soft tool"[1] fabrication have reduced the need for many of the small items of special tooling. Manufacturers are able to produce inexpensive tooling designed to last only for a given job. When the contract is completed, this tooling can be discarded if no future use is expected. The advantage of producing this type of equipment is that transportation costs are eliminated and the contractor avoids the risk of receiving government-owned tooling which is defective or incomplete. Storage and opportunity costs are also avoided through the use of this type of tooling.

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[1]Soft tooling is tooling/test equipment fabricated for temporary use, for the manufacture of a minimum number of items. (23:7-170)

As a system ages, a portion of the tooling becomes obsolete and a great amount of the test equipment wears out. Consequently, a substantial percentage of the initial ST/STE inventory becomes unusable in a short time. Past management procedures have not been able to keep pace with these developments. In one case a contractor received government-owned special tooling for the manufacture of aircraft canopies. Some of this tooling had been used on a yearly basis by another contractor who had been successful in obtaining the contract, year after year. However, much of the tooling had become obsolete. As technology had developed in this area, the former contractor had developed new tooling at his own expense. The result was that the new contractor was unable to use the government-owned tooling and eventually defaulted on the contract, leaving the Government in a critical inventory position on aircraft canopies.

Although the Sacramento Air Materiel Area includes an "As is, where is" clause in all IFB's and RFP's, in many instances the contractor is unable or unwilling to invest the time and expense necessary to inspect the equipment. Although he has been informed that the Government bears no liability when tooling is unusable, the expense involved in performing an inspection is oftentimes too great. Therefore, some contractors take a risk and make a bid in hopes that the ST/STE will be serviceable and adaptable to their operation. When a problem develops with the tooling, both the contractor and the Government lose in the transaction. The contractor has

expended money in shipping charges and may be forced to retool at his own expense. The Government suffers because the lead time increases greatly. This can prove critical in the case of not operationally ready supply (NORS) items and mission essential items. The conclusion here is that the inadequate means of managing the ST/STE inventory results in substantial problems which could and should be avoided.

Conclusion

The research question to which this study seeks an answer is, as stated in Chapter 1:

> Is it economical for the Air Force to maintain an inventory of special tooling and special test equipment on its defense systems?

Based upon the findings of this study as described herein, it must be concluded that:

> It is economical for the Air Force to maintain an inventory of special tooling and special test equipment on its defense systems.

Other Conclusions

There are some subsidiary questions which deserve attention and which are supported by findings herein. The conclusions based upon those findings are as follows:

1. Automation is essential to the efficient management of ST/STE. It has been shown that automation significantly enhances the operation of the management process.

2. The ST/STE disposal screening process should be comprehensive and continuous and it should be initiated as early as practicable and economical in the life of the ST/STE. There should be a complete screening during or at the completion of the initial acquisition contract. This should

continue until all items have been disposed of. The implication is made that disposal actions should be taken at the earliest practical date on those items for which no future need exists. It also implies that all items retained should be utilized to the fullest extent.

3. Generally, ST/STE yields contract price reductions, enhances competition, promotes equal treatment to all potential bidders, and contributes to the national defense and industrial mobilization.

Chapter 5

RECOMMENDATIONS

In concluding this thesis, it is now appropriate to describe the actions which should be taken to remedy or improve the conditions described in the preceding chapter.

The recommendations which follow, titled Pertinent Recommendations, pertain to conclusions of the preceding chapter. The remaining recommendations are not directly supported by the findings and conclusions set out in this thesis. However, the authors felt that these recommendations were important enough to the subject of ST/STE management to be mentioned.

The two sections of recommendations are appropriately titled "Pertinent Recommendations" and "Other Recommendations" respectively.

Pertinent Recommendations

Based upon the Other Conclusions reached in the preceding chapter, the Air Force should:

1. Aggressively pursue full utilization of automation of all ST/STE management systems. It was recently learned that all AMA's now have authority to implement CO 17 for use in the management of ST/STE; however, this system is not being fully utilized due to problems encountered in item

identification.

The preponderance of ST/STE items are old and have never been identified with adjoining parts. It is senseless to enter an ST/STE item on the computer if it cannot be identified with its adjoining parts and the defense system (e.g., aircraft) part or component which it produces.

SMAMA has already experienced these difficulties and has virtually eliminated them. The experience gained by SMAMA could go far in helping the AMA's to avoid identification problems. In line with that, an education program should be established which would afford maximum advantage of SMAMA's experiences with CO 17.

Notwithstanding the benefit to be gained through transmission of SMAMA's knowledge to others, much long and arduous labor would be required to bring all ST/STE management systems up to a level of full utilization. However, regardless of the work and one-time costs involved, it is believed that the Air Force would soon be reaping the benefits of automation and that the benefits would far exceed the costs. The sooner full utilization is realized, the sooner the Air Force will realize net benefits in the management of ST/STE. Thus, recommendation of aggressive pursuit of that objective.

2. Develop a program which would insure that all items of ST/STE which are not mission essential and not economical to retain are disposed of at the point where they become uneconomical to retain, i.e., where costs start to

exceed the projected benefits. The responsibility and authority for administering the program on any defense system should be given to the Deputy System Program Director for Logistics (DSPD/Log) within the particular System Program Office.

The DSPD/Log is an AFLC officer (generally a system manager) temporarily assigned to a Program Office in Air Force Systems Command (AFSC) for the duration of the acquisition process of the pertinent defense system program. When the defense system is turned over to AFLC for the operational phase, the DSPD/Log normally becomes the system manager for that weapon system.

It is realized that this man is very busy and has little time to spend on ST/STE problems. Therefore, the recommendation is made that the authority for administering the program be given to an individual familiar with tooling. He should be appointed as an extra individual to the SPO office and should be vested with the authority to make determinations, decisions, and provide guidance relative to ST/STE.

Such a program should consist of four parts: ST/STE item identification, usage requirement determination, screening, and disposal. These are delineated below:

a. A system should be established which would result in the identification of all items of ST/STE with their adjoining or associated items of tooling or equipment and with the respective defense system part number. SMAMA now employs an identification procedure which is believed to be

suitable for this purpose. This identification system would aid in the accomplishment of recommendations b, c, and d below.

b. Usage requirement determination should be accomplished prior to acquisition of the ST/STE. This possibly could be performed in conjunction with system contractor estimates and data generated in Category I and II testing.

Using data generated on ST/STE fabricated by the contractor, a system should be employed to identify items which may be required as spare parts and the ST/STE required to manufacture these items. Presently tooling which produces spare parts is identified with a "P" code. However, difficulty is being encountered in getting this identification code placed in AFSC contracts and if included initially, problems arise in keeping it on the contract.

c. The Air Force Logistics Command and Systems Command should divest themselves of all ST/STE not mission essential and all items not projected to be required for future production or spare parts requirements. This can only be accomplished by a comprehensive and continuous screening process. It is recommended that AFSC retain responsibility for the production and mobilization tooling which might be required if full production of the end item is to take place after contract completion. On the other hand, AFLC should then be responsible for the tooling which produces spare parts (P coded items) in support of the defense system.

d. Disposal action should be initiated at the earliest practicable date on items for which there is no projected requirement. The possibility should be explored to salvage items of ST/STE to manufacturers for usage on future government contracts. If this proves to be impossible, the ST/STE can always be sold for the scrap value of the metal alone or abandoned in place.

The first possible avenue of disposal is potential producers--those who may have aspirations of producing parts or materials sometime in the future. It is realized that, in the past, this has not been a very lucrative channel. However, under the rules of economy recommended above, there may be situations in which it would be economically feasible for a contractor to maintain the ST/STE, although not so for the Air Force. It is believed that a nominal effort in this direction may be financially rewarding.

For all items not saleable to potential contractors, there are two alternatives remaining: formal disposal sales actions and abandonment in place.

Formal disposal sales actions have historically been an item of net <u>expenditure</u> instead of a source of net <u>revenue</u>. This is due to two factors: the law governing deposits from sale of salvaged property and the actual returns from those sales.

By law, the returns from formal disposal sales actions are deposited in the General Fund of the U. S. Treasury. The Air Force should attempt to have the law revised so that

returns from the sale of Air Force property will be deposited to an Air Force account, preferably the one from which the sale was made. In addition to being equitable, (it is inequitable for the Air Force to bear the administrative cost of conducting the sale and then being deprived of the returns from the sale), such a revision would be in keeping with the Resource Management System (RMS) concept of <u>responsibility center management</u>. This concept states that a manager of assets or resources should be given 100% responsibility for resources consumed and 100% credit for returns realized.

The inherent low value of ST/STE items is an unavoidable fact in the formal disposal sales actions. However, the Air Force could possibly be selective in its disposal actions. The ST/STE items usually yield returns equal to or less than the worth of the metals contained in them. All metals except lead and kirksite are virtually worthless from a salvage point of view. The Air Force should investigate the cost effectiveness of conducting formal disposal sales actions for items containing lead and kirksite.

Where it is cost effective, practicable, and legal, ST/STE should be abandoned in place. Abandonment, though a poor alternative, in many cases is the only cost effective method of paring a ST/STE inventory.

<u>Other Recommendations</u>

The Air Force should:

1. Store all ST/STE in government-owned and operated

facilities. This has been shown to be less expensive than storing in contractor owned or operated facilities. The Air Force owns numerous large facilities throughout the country which are presently not fully utilized and which would be suitable for storing ST/STE. When there are alternative storage sites available, transportation cost should be a factor in choosing the alternative.

2. Conduct a cost effectiveness study on centralization of the ST/STE management information system. If centralization of computer capability would be equally effective and less costly or would be equally costly and more effective, it should be accomplished. There would be benefits to be realized through the use of a smaller but more qualified staff and in the consolidation of electronic data processing hardware. The computer should be controlled by Hq AFLC. It could be physically located at Wright-Patterson AFB, at any of the AMA's, or practically anywhere in the United States. The location chosen would be determined by the cost effectiveness relationships of the various alternatives.

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APPENDIXES

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APPENDIX A

TOOLING AVOIDANCE

TOOLING AVOIDANCE

The determination of the utilization of ST/STE during the period of this study was a crucial factor in the success of the endeavor. The re-utilization of ST/STE is considered the key factor to the study because the sole purpose for the retention of the ST/STE inventory is to re-use it at a later date.

The records maintained in this area are incomplete, but usable. Since the reporting of utilization rates on ST/STE has never been mandatory, the existence of such information was anticipated to be incomplete. The recording of utilization rates since mid 1968, though continuous, did have gaps, especially in the F-100 system. Where such voids appear, assumptions have been made.

F-100

A SMAMA daily morning report dated 12 July 1971 stated that 4,672 items of ST/STE with an estimated value (initial cost) of $2,245,344 had been used between 1 January 1967 and 30 June 1971. (17) This amounts to an average value of $481 per item of F-100 ST/STE utilized. As a minimum, it was assumed that an average of $481 is saved in procurement costs alone each time an item of F-100 ST/STE is used. When the value of the ST/STE utilized was uncertain, the figure of $481 was used as the value of each unknown item.

Determining the amount of ST/STE used during a fiscal year period was difficult because most reports were in terms of calendar years. Utilization rates on the F-100 included:

Table 11

F-100 ST/STE Utilization
1 Jan 68 - 30 Sep 71

Time Period	Quantity of ST/STE	Value (1954 Dollars)(17)
1 Jan 68 - 31 Dec 68	1,387	$667,147
1 Jan 69 - 31 Dec 69	1,073	$619,498
1 Jan 70 - 31 Dec 70	398	$236,337
1 Jan 71 - 30 Sep 71	214	$ 70,895

By Mid 1969, records were kept on a monthly basis. Utilization rates recorded monthly from this time total:

Table 12

F-100 ST/STE Utilization, FY 70

Month	Quantity of ST/STE	Value (1954 Dollars)
July 1969	112 (estimated)	$ 52,910 (estimated)
August	79	41,914
September	96	45,592
October	162	132,084
November	26	19,794
December	100	86,704
January 1970	48	34,944
February	24	13,851
March	59	44,448
April	27	12,103
May	61	28,925
June	62	34,891
Total FY 70	856	$548,160

Table 13

F-100 ST/STE Utilization, FY 71

Month	Quantity of ST/STE	Value (1954 Dollars)
July 1970	9	$ 7,875
August	52	24,873
September	16	10,562
October	15	5,383
November	17	16,294
December	8	2,188
January 1971	66	40,827
February	0	0
March	9	4,089
April	0	0
May	85	6,423
June	0	0
Total FY 71	277	$118,514

Records revealed that 3,487 items of F-100 ST/STE were used between 1 January 1967 and 30 June 1969. It was also evident that tool utilization has steadily declined since 1967 as activity in the Viet Nam war has subsided. Based on these assumptions, tooling utilization during this period was broken down as follows:

Table 14

F-100 ST/STE Utilization
1 Jan 67 - 30 Jun 69

Year	Quantity of ST/STE	Value (1954 Dollars)
1 Jan 67 - 31 Dec 67	1602	$ 770,562
1 Jan 68 - 31 Dec 68	1387	667,147
1 Jan 69 - 30 Jun 69	498	224,518
	3487	$1,662,227

The quantity and value of ST/STE used during the FY 69-71 period was then determined as follows:

Table 15

F-100 ST/STE Utilization
FY 69 - FY 71

Year	Quantity of ST/STE	Value (1954 Dollars)
FY 1969	1,191	$ 584,781
FY 1970	856	548,160
FY 1971	277	118,514
Total	2,324	$1,251,455

F-105

A fairly accurate record of ST/STE utilization on the F-105 system was available between 1 July 1968 and 30 June 1971. The inventory manager of the F-105 at SMAMA had a listing of the quantity of ST/STE utilized by quarter since 1 July 1968 with the dollar values of the items used. A listing of the quantity and value of the ST/STE utilized during the period of this study includes:

Table 16

F-105 ST/STE Utilization

Quarter	Quantity of ST/STE	Value (1958 Dollars)(16)
1 July - 30 Sept 1968	1,558	$ 727,884
1 Oct - 31 Dec 1968	1,154	409,110
1 Jan - 31 Mar 1969	470	218,711
1 Apr - 30 Jun 1969	650	370,174
FY 1969	3,832	$1,725,879

Table 16 (continued)

Quarter	Quantity of ST/STE	Value (1958 Dollars)
1 July - 30 Oct 1969	105	$ 46,448
1 Oct - 31 Dec 1968	130	77,743
1 Jan - 31 Mar 1970	309	133,738
1 Apr - 30 Jun 1970	221	183,629
FY 1970	765	$441,558
1 July - 30 Sep 1970	63	$ 44,686
1 Oct - 31 Dec 1970	798	558,886
1 Jan - 31 Mar 1971	283	215,483
1 Apr - 30 Jun 1971	172	79,766
FY 1971	1,316	$898,821

Table 17

Total Utilization by System
FY 69 - FY 71

System	Quantity	Value
F-100	2,324	$1,251,781 (1954 dollars)
F-105	5,913	$3,066,258 (1958 dollars)

Inflation

The values portrayed for the items of ST/STE used on both weapon systems are in terms of initial acquisition cost. In the case of the F-100, the majority of the ST/STE was purchased between 1952 and 1954; while with the F-105, most of

the ST/STE was purchased between 1956 and 1958. Since that time, the American economy has noted a significant increase in the price index. The cost of labor, materials, and engineering skill have all experienced consistent increases through the years. Consequently, it would be unrealistic to claim only the original acquisition price as a cost saving in holding ST/STE.

The manufactured goods listing of the wholesale price index has been applied to the original acquisition costs of all ST/STE utilized on both weapon systems.

F-100

For purposes of analysis, it has been assumed that the majority of F-100 ST/STE was purchased in 1954. Consequently, the wholesale price index was based on the year 1954 for this weapon system. In developing this index, it was necessary to combine a Wholesale Price Index based in 1958 and one based in 1967 in order to cover the time period 1954 to 1971. An error is generated when Price Indices with different base periods are combined. Therefore, a small error was undoubtedly calculated into the revised index. However, this error was considered insignificant in regards to the outcome of this study.

Table 18

Inflation Index, F-100

Year	Wholesale Price Index Manufactured Goods (24)
1954	100.0
1958	109.3
1967	116.3
1969	121.3
1970	126.5
1971	130.0

The index was calculated for January of each year. The application of this index to each of the years of this study yielded the actual value of the tooling utilized during the study.

Table 19

Adjusted Value of Tooling Utilization, F-100

Year	Value (1954 dollars)		Index		Value
1969	$584,781	x	121.3	=	$ 709,339
1970	$548,160	x	126.5	=	693,422
1971	$118,514	x	130.0	=	154,068
Total					$1,556,829

F-105

In this analysis, it has been assumed that the majority of F-105 ST/STE was purchased in 1958. Therefore the wholesale price index was based on the year 1958 for this weapon system.

Table 20

Inflation Index, F-105

Year	Wholesale Price Index Manufactured Goods (24)
1958	100.0
1967	106.4
1969	111.0
1970	115.7
1971	118.9

As with the F-100, the index was calculated for January of each year. The application of this index to each of the years of this study yielded the actual value of the tooling utilized during the study.

Table 21

Adjusted Value of Tooling Utilization, F-105

Year	Value (1958 dollars)		Index		Value
1969	$1,725,879	x	111.0	=	$1,915,573
1970	$ 441,558	x	115.7	=	510,883
1971	$ 898,821	x	118.9	=	1,068,698
Total					$3,495,154

APPENDIX B

SCRAP VALUE OF ST/STE

SCRAP VALUE OF ST/STE

In determining the scrap value of the special tooling and special test equipment for the F-100 and F-105 systems, it was decided to use data from an agency that recently concluded a salvage sale of ST/STE. The Naval Plant Representative Office at the Lockheed Aircraft Corporation in Burbank, California concluded several sales totaling 4,058 items of F-104 ST/STE early in 1971. (2) Since the tooling sold was considered comparable to F-100 and F-105 ST/STE, the F-104 figures will be projected to the two systems under study.

Past experience in the salvage of special tooling has indicated that approximately 96% of the items of tooling are comprised of steel and aluminum. Historically, tooling containing these types of metals have sold at an average of $1.05 per tool. The remaining 4% of the tooling is composed of the heavier lead and kirksite tooling which averages $142 per tool. (13)

By the time a defense system reaches the age of the F-100 and F-105, very little special test equipment remains in the ST/STE inventory. Most of the test equipment has been consumed in the earlier life of the system. Inventory managers for STE at SMAMA estimate that of the total inventory of ST/STE on the records, approximately 5% is special test equipment, the remaining 95% is comprised of special tooling. It

is a very difficult task to estimate the value of an item of special test equipment. Generally, an item of special test equipment can only be salvaged through a junk dealer. Prices received for such pieces vary with the complexity of the equi-ment, its age and condition, and the expected value as seen by the dealer. However, an approximation will be made that the average value of the STE remaining on the SMAMA inventory for the F-100 and F-105 is $10 per item.

F-100

Salvage value of the ST/STE for the F-100 weapon system is calculated as follows:

Table 22

Salvage Value, F-100 ST/STE

FY 69

Quantity of ST/STE		% of STE		Quantity of STE
47,222	x	5%	=	2,361
Quantity of ST/STE		% of ST		Quantity of ST
47,222	x	95%	=	44,861
Quantity of ST		% Lead & Kirksite		Quantity of Ld & Kste
44,861	x	4%	=	1,794
Quantity of ST		% Steel & Aluminum		Quantity of St & Al
44,861	x	96%	=	43,067

Category	Quantity		Value/Item		Salvage Value
STE	2,361	x	$ 10.00	=	$ 23,610
ST (L & K)	1,794	x	$142.00	=	254,748
ST (S & A)	43,067	x	$ 1.05	=	45,220
Total					$323,578

FY 70

Quantity of ST/STE		% of STE		Quantity of STE
46,616	x	5%	=	2,331
Quantity of ST/STE		% of ST		Quantity of ST
46,616	x	95%	=	44,285
Quantity of ST		% Lead & Kirksite		Quantity of Ld & Kste
44,285	x	4%	=	1,771
Quantity of ST		% Steel & Aluminum		Quantity of St & Al
44,285	x	96%	=	42,514

Category	Quantity		Value/Item		Salvage Value
STE	2,331	x	$ 10.00	=	$ 23,310
ST (L & K)	1,771	x	$142.00	=	251,482
ST (S & A)	42,514	x	$ 1.05	=	44,640
Total					$319,432

FY 71

Quantity of ST/STE		% of STE		Quantity of STE
21,799	x	5%	=	1,090
Quantity of ST/STE		% of ST		Quantity of ST
21,799	x	95%	=	20,709
Quantity of ST		% Lead & Kirksite		Quantity of Ld & Kste
20,709	x	4%	=	828
Quantity of ST		% Steel & Aluminum		Quantity of St & Al
20,709	x	96%	=	19,881

Category	Quantity		Value/Item		Salvage Value
STE	1,090	x	$ 10.00	=	$ 10,900
ST (L & K)	828	x	$142.00	=	117,576
ST (S & A)	19,881	x	$ 1.05	=	20,775
Total					$149,251

F-105

Salvage value of the ST/STE for the F-105 weapon system is calculated as follows:

Table 23

Salvage Value, F-105 ST/STE

FY 69 & 70

Quantity of ST/STE		% of STE		Quantity of STE
35,651	x	5%	=	1,783
Quantity of ST/STE		**% of ST**		**Quantity of ST**
35,651	x	95%	=	33,868
Quantity of ST		**% Lead & Kirksite**		**Quantity of Ld & Kste**
33,868	x	4%	=	1,355
Quantity of ST		**% Steel & Aluminum**		**Quantity of ST & Al**
33,868	x	96%	=	32,513

Category	Quantity		Value/Item		Salvage Value
STE	1,783	x	$ 10.00	=	$ 17,830
ST (Ld & K)	1,355	x	$142.00	=	192,410
ST (S & L)	32,513	x	$ 1.05	=	34,139
Total					$244,379

FY 71

Quantity of ST/STE		% of STE		Quantity of STE
19,801	x	5%	=	990
Quantity of ST/STE		**% of ST**		**Quantity of ST**
19,801	x	95%	=	18,811
Quantity of ST		**% Lead & Kirksite**		**Quantity of Ld & Kste**
18,811	x	4%	=	752
Quantity of ST		**% Steel & Aluminum**		**Quantity of St & Al**
18,811	x	96%	=	18,059

Category	Quantity		Value/Item		Salvage Value
STE	990	x	$ 10.00	=	$ 9,900
ST (L & K)	752	x	$142.00	=	106,784
ST (S & A)	18,059	x	$ 1.05	=	18,962
Total					$135,646

Disposal Costs

The study of salvage values cannot be concluded without a recognition of the costs incurred in disposing of this tooling and equipment. Although accurate costs are not recorded for disposal actions, these costs are substantial. The Plant Clearance Officer (PCO) at the Naval Plant Representative Office (NAVPRO) for the Lockheed Aircraft Corporation in Burbank, California estimated the minimum cost for each sale of ST/STE at $700. Most sales involve 2,500 pieces of ST/STE or less. Included in this figure are advertisement and postage fees, administrative charges, and a small portion of the wages for the government personnel involved in the sale. This figure does not include the many hours spent screening and inventorying the material as well as the time required to process the paperwork involved.

An indication of the high expense of salvaging ST/STE can be seen in the case of the F-104 tooling at the Lockheed plant. The contractor has submitted a bill for $510,000 for screening and generating an inventory list of 10,000 items of F-104 ST/STE. (13) This alone averages out to over $50 per item, not to mention the expense that will be incurred by the Plant Clearance Officer in the actual sale of the equipment.

Special tooling and special test equipment, when sold by the Plant Clearance Officer, are sold on a sealed bid basis. Bids are normally mailed to several hundred prospective bidders. These bidders can then inspect the tooling and equipment and submit a bid if interested. Funds generated

through the salvage of ST/STE are forwarded to the Air Force Finance Officer who in turn places the money into the General Fund of the U. S. Treasury.

Although precise costs were not readily available on these disposal functions, it is evident that the $1.05 realized per steel or aluminum tool and the $142 per lead and kirksite tool can barely cover the sales costs. The many hours of personnel wages expended in disposal sales alone frequently absorb all the profits of such sales.

Because the costs incurred in the <u>salvage</u> of ST/STE are so great, it is not considered appropriate to list salvage value as a tangible benefit in holding ST/STE. Therefore, a figure of <u>zero</u> will be inserted into the benefit equation for the salvage value category.

APPENDIX C

TRANSPORTATION COSTS

TRANSPORTATION COSTS

During the time encompassed by this study, two basic costs have been incurred in the transportation area. In fiscal year 1970, most of the ST/STE for the F-100 system was moved from contractor storage areas to government-owned storage areas, while F-105 tooling was moved in fiscal year 1971. The result was several large shipping charges to the Government contained on Government Bills of Lading (GBL).

Contractor movement of ST/STE from storage areas to the place of contract performance generated the second basic transportation cost. The costs of transportation borne by contractors have increased as the Government has moved items of ST/STE to government-owned storage sites. Whereas contractor shipments of ST/STE were minimal before centralized storage, now a contract utilizing government-owned ST/STE is almost assured of a movement of the tooling.

Government Bill of Lading

In the campaign to move government-owned special tooling and special test equipment to government warehouses, five substantial bills of lading were generated. Although these moves were of a one-time nature, it is important that they not be overlooked. These costs were generated during the time of this study and must be considered as a cost of maintaining ST/STE. Care must be used in applying these

costs to future years of the systems or to future weapon systems.

F-100

Two GBL's were generated by the movement of F-100 and F-86 ST/STE, one moved tooling to Palmdale, California from the Los Angeles basin, while the second smaller move transported heavy salvage value items to SMAMA from the Los Angeles basin. The quantity of F-86 ST/STE included in these moves was very slight. Estimates place the quantity of this type tooling at approximately 5%. Therefore, 5% of the transportation costs will be subtracted as being inapplicable to the F-100 system. The figures on these moves include:

Table 24

Cost of ST/STE Relocation, F-100

Move to Palmdale (14)	
Cost	$20,0[illegible]2
Distance	65 miles
Number of items	29,599 tools
Number of truckloads	235
Average number of items/truck	126 tools (assumption)
Cost per truckload	$90
Average cost per item	71¢
Move to SMAMA (14)	
Cost	$4,771
Distance	400 miles
Number of items	[illegible]5 tools (av wt [illegible]100 lbs)
Number of truckloads	35
Average number of items/truck	20 tools (assumption)
Cost per truckload	$157
Average cost per item	$7.8[illegible]

F-105

Three major GBL's were generated by the movement of F-105 ST/STE: one moved tooling to Griffiss AFB, New York from Farmingdale, New York, while the other two transported tooling from two manufacturers in Wichita, Kansas to Griffiss. Figures on these moves include:

Table 25

Cost of ST/STE Relocation, F-105

Move from Farmingdale (1)	
Shipping Cost.	$ 25,332
Packing and Outloading	104,223
Total.	$129,555
Distance	275 miles
Number of items.	14,899 tools
Number of truckloads	118 (assumption)
Average number of items/truck. . . .	126 tools (assumption)
Cost per truckload	$215
Average shipping cost per item . . .	$1.70
Packing and Outloading per tool. . .	$7

Move from Wichita (1)	
Shipping Cost.	$ 3,066
Packing and Outloading	19,536
Total.	$22,602
Distance	1,500 miles
Number of items.	1,628 tools
Number of truckloads	13 (assumption)
Average number of items/truck. . . .	126 tools (assumption)
Cost per truckload	$236
Average shipping cost per item . . .	$1.88
Packing and Outloading per tool. . .	$12

Table 25 (continued)

Move from Wichita (1)	
Shipping Cost	$ 4,717
Packing and Outloading	16,224
Total	$20,941
Distance	1,500 miles
Number of items	1,352 tools
Number of truckloads	[illegible] (assumption)
Average number of items/truck	126 tools (assumption)
Cost per truckload	$429
Average shipping cost per item	$3.49
Packing and Outloading per tool	$12

It must be noted that all of these shipments consisted of high volume moves on a Government Bill of Lading.[1] When a contractor ships ST/STE for use on a contract, his move is never on a GBL and never consists of the high volume indicated by these data.

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[1]Although the Government Bill of Lading and the Commercial Bill of Lading are quite similar in purpose, there exists one noteworthy distinction in this case. The Government can and does secure reduced rates under Section 22 of the Interstate Commerce Commission Act. This section of the ICC Act grants the Government free or reduced rates under four major stipulations. These include:

a. Some equipment and materiel peculiar to the military, or seldom if ever, found in private commerce.

b. Many military installations are located outside of commercial centers for which established traffic patterns and published commodity rates exist.

c. Military traffic generally loads heavier than commercial traffic.

d. Military shipments usually are packed better than commercial shipments because of the prospect of ocean movement and rough handling under field conditions.

The Government has used both a and c as its authority for reduced rates under Section 22. (7:7-12 & 13)

Commercial Bill of Lading

In the transportation area it is impossible to obtain accurate figures on the number of tools moved in any one year, the weight of the tools moved, or the distance these tools were moved. Therefore, several key assumptions have been made in order to include this transportation function as a viable area of study. These assumptions include:

1. Round Trip. The mileage figures presented in this appendix are all one-way distances. It will be assumed that the contractor returns these items during the same year, consequently doubling the mileage figure. The Armed Services Procurement Regulation requires that all ST/STE be returned to the Government within 15 days of completion of a contract. (6:7-104.24) Therefore, it is assumed that a contractor would include the round trip transportation cost for each item of ST/STE in his contract price.

2. Shipping Distances. It is impossible to determine the exact distance each item of ST/STE utilized was moved during the course of a year. Therefore, it was necessary to make an assumption on the average distance of a tool move and the percentage of items moved at the varying distances. These figures were developed with the aid of experts in the field at SMAMA.

Table 26

F-100 Tool Movement

Year	Distance Moved	% of ST/STE Moved
FY 1969 & 70	25 miles	35%
	1500 miles	5%
	0 miles	60%
		100%
FY 1971	65 miles	82%
	1500 miles	15%
	0 miles	3%
		100%

Table 27

F-105 Tool Movement

Year	Distance Moved	% of ST/STE Moved
FY 1969	50 miles	10%
	1500 miles	2%
	0 miles	88%
		100%
FY 1970	50 miles	52%
	1500 miles	15%
	3000 miles	25%
	0 miles	8%
		100%
FY 1971	50 miles	45%
	275 miles	7%
	1500 miles	15%
	3000 miles	25%
	0 miles	8%
		100%

Shipping Costs

In determining the shipping charges paid by contractors, current rates were obtained from the trucking industry. For the purpose of this study, it has been

estimated that all moves over 100 miles were shipped in truckload quantities at truckload rates with the exception of the 275-mile distance between Griffiss AFB and Farmingdale, New York. It was determined that 85% of the moves of 100 miles or less were truckload (TL) quantities at truckload rates, the remaining 15% shipped in less than truckload (LTL) lots. In the Griffiss AFB to Farmingdale case, it has been assumed that 90% of the moves were truckload quantities. The following rates were quoted on item #119420, NMFC A-12, dies:

Table 28

F-100 Truckload Rates (9)

Los Angeles, Calif to Kerrville, Texas		1400 miles-	$105.60
Los Angeles, Calif to Wichita, Kasnas		1500 miles-	$ 99.20
El Segundo, Calif to Norwalk, Calif		25 miles-	
	Truckload		$ 16.20
LTL:	one item, 200 lbs, 9 cubes		$ 8.80
	one item, 100 lbs, 4 cubes		$ 6.25
	one item, 20 lbs, 1 cube		$ 4.10
Palmdale, Calif to Los Angeles, Calif		65 miles	
	Truckload		$ 18.45
LTL:	one item, 200 lbs, 9 cubes		$ 8.80
	one item, 100 lbs, 4 cubes		$ 6.25
	one item, 20 lbs, 1 cube		$ 4.10

Table 29

F-105 Truckload Rates (9)

Farmingdale, New York to Wichita, Kansas	1500 miles-	$ 85.68
Farmingdale, New York to Los Angeles,Cal	3000 miles-	$153.84
Farmingdale, New York to Rome, New York	275 miles-	$ 34.56
Farmingdale, New York to Hoboken, N.J.	50 miles-	

Table 29 (continued)

	Truckload	$ 18.48
LTL:	one item, 200 lbs, 9 cubes	$ 10.01
	one item, 100 lbs, 4 cubes	$ 9.63
	one item, 20 lbs, 1 cube	$ 9.63
Rome, New York to Farmingdale, New York	275 miles	
	Truckload	$ 34.56
LTL:	one item, 200 lbs, 9 cubes	$ 12.04
	one item, 100 lbs, 4 cubes	$ 10.90
	one item, 20 lbs, 1 cube	$ 10.90

Table 30

Contractor Shipping Charge, F-100 ST/STE

FY 69

Tools Utilized	x	Per Cent Moved	=	Number Tools Moved
1191	x	35%	=	397 tools moved 25 miles
1191	x	5%	=	60 tools moved 1500 miles
1191	x	60%	=	734 tools moved zero miles

397 tools x 85% = 337 tools moved 25 miles at a truckload rate

$$\frac{337}{126} = \text{approximately 3 truckloads}$$

The remaining 60 tools were shipped at LTL rates.

Total Costs, F-100, FY 69

3 truckloads (25 miles)	$ 49.00
60 tools LTL (25 miles)	375.00
1 truckload (1500 miles)	100.00
	$524.00 x 2 (roundtrip) = $1,048

Table 30 (continued)

FY 70

Tools Utilized	x	Per Cent Moved	=	Number Tools Moved
856	x	35%	=	300 tools moved 25 miles
856	x	5%	=	43 tools moved 1500 miles
856	x	60%	=	513 tools moved zero miles

300 tools x 85% = 255 tools moved 25 miles at a truckload rate

$\frac{255}{126}$ = approximately 3 truckloads

The remaining 45 tools moved at LTL rates.

Total Costs, F-100, FY 70

3 truckloads (25 miles)	$ 49.00
45 tools LTL (25 miles)	281.00
1 truckload (1500 miles)	100.00
	$430.00 x 2 (roundtrip) = $860

FY 71

Tools Utilized	x	Per Cent Moved	=	Number Tools Moved
277	x	82%	=	227 tools moved 65 miles
277	x	15%	=	42 tools moved 1500 miles
277	x	3%	=	8 tools moved zero miles

227 tools x 85% = 193 tools moved 65 miles at a truckload rate

$\frac{193}{126}$ = approximately 2 truckloads

The remaining 34 tools were shipped at LTL rates.

Total Costs, F-100, FY 71

2 truckloads (65 miles)	$ 36.90
34 tools LTL (65 miles)	212.50
1 truckload (1500 miles)	100.00
	$349.40 x 2 (roundtrip) = $698.30

Table 31

Contractor Shipping Charge, F-105 ST/STE

FY 69

Tools Utilized	x	Per Cent Moved	=	Number Tools Moved
3832	x	10%	=	383 tools moved 50 miles
3832	x	2%	=	77 tools moved 1500 miles
3832	x	88%	=	3372 tools moved zero miles

383 tools x 85% = 326 tools moved 50 miles at a truckload rate

$\frac{326}{126}$ = approximately 3 truckloads

The remaining 57 tools were shipped at LTL rates.

Total Costs, F-105, FY 69

3 truckloads (50 miles)	$ 55.44
57 tools LTL (50 miles)	570.00
1 truckload (1500 miles)	85.68
	$711.12 x 2 (roundtrip) = $1,422.24

FY 70

Tools Utilized	x	Per Cent Moved	=	Number Tools Moved
765	x	52%	=	398 tools moved 50 miles
765	x	15%	=	115 tools moved 1500 miles
765	x	25%	=	191 tools moved 3000 miles
765	x	8%	=	61 tools moved zero miles

398 tools x 85% = 338 tools moved 50 miles at a truckload rate

$\frac{338}{126}$ = approximately 3 truckloads

The remaining 60 tools were shipped at LTL rates.

Total Costs, F-105, FY 70

3 truckloads (50 miles)	$ 55.44
60 tools LTL (50 miles)	600.00
1 truckload (1500 miles)	85.68
2 truckloads (3000 miles)	307.68
	$1,048.80 x 2 (roundtrip) = $2,097.60

Table 31 (continued)

FY 71

Tools Utilized	x	Per Cent Moved	=	Number Tools Moved
1316	x	45%	=	592 tools moved 50 miles
1316	x	7%	=	92 tools moved 275 miles
1316	x	15%	=	197 tools moved 1500 miles
1316	x	25%	=	330 tools moved 3000 miles
1316	x	8%	=	105 tools moved zero miles

592 tools x 85% = 503 tools moved 50 miles at a truckload rate

$\frac{503}{126}$ = approximately 4 truckloads

The remaining 89 tools were shipped LTL rates.

Total Costs, F-105, FY 71

4 truckloads (50 miles)	$ 73.92
89 tools LTL (50 miles)	890.00
2 truckloads (1500 miles)	171.36
3 truckloads (3000 miles)	461.52
	$1,596.80 x 2 (roundtrip) =
	$3,193.60

APPENDIX D

CO 17 SYSTEM OPERATING COSTS

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CO 17 SYSTEM OPERATING COSTS

The CO 17 system relies heavily on the IBM 7080 and 1401 computers. The 7080 handles all of the computations, while the 1401 serves in an input/output capacity. Three basic costs are incurred in the operation of the system. These costs include the salaries paid to employees developing and operating the system, machine rental time, and computer operator salaries. A breakdown of CO 17 costs include: (18)

Basic Costs Per Hour

Salary

Development Time	$7.40/hour
System Maintenance Time	$7.40/hour
Mission Time	$6.67/hour

Machine Rental

IBM 7080	$180/hour
IBM 1401	18/hour

Operator Cost

IBM 7080 requires an average of 4.5 operators per hour.
IBM 1401 requires 1 operator per hour.

Operator Cost	$5.57/hour
IBM 7080 Operator Cost	$26.065/hour
IBM 1401 Operator Cost	$5.57/hour

Table 32

CO 17 Manhours Consumed

	Development		Mission	
	Hours	Dollars	Hours	Dollars
Oct 68 - Jun 69	6446	$ 47,700	248	$1,654
Jul 69 - Jun 70	8236	60,947	337	2,248
Jul 70 - Jun 71	2503	18,522	234	1,561
Total	17,185	$1,271,169	819	$5,463

Table 32 (continued)

	System Maintenance	
	Hours	Dollars
Oct 68 - Jun 69	328	$ 2,427
Jul 69 - Jun 70	534	3,952
Jul 70 - Jun 71	925	6,845
Total	1,787	$13,224

Table 33

Total Dollars/Manhours, CO 17

Year	Total	System Maintenance Cost
Oct 68 - Jun 69	$ 51,782	$ 2,427
Jul 69 - Jun 70	67,146	3,952
Jul 70 - Jun 71	26,928	6,845
Total	$145,856	$13,224

System maintenance costs have been highlighted in the second column because they are continuing costs and may be useful to the reader in determining the cost of operating the system. Developmental and Mission costs have been excluded in this column because they are considered sunk costs which are incurred only in system development. The three costs are included in the "total" column to illustrate the entire cost of the CO 17 system to SMAMA.

Table 34

CO 17 Machine Hours Consumed

Year	Development		System Maintenance	
	1401	7080	1401	7080
Oct 68 - Jun 69	45	33	8	4
Jul 69 - Jun 70	49	47	25	49
Jul 70 - Jun 71	78	83	239	103
Total	172	163	272	156

Table 35

Total Dollars/Machine Hours

Year	1401	7080	Total	System Maintenance Cost
Oct 68-Jun 69	$ 1,249	$ 7,487	$ 8,736	$ 864
Jul 69-Jun 70	1,744	19,686	21,430	9,020
Jul 70-Jun 71	7,471	38,142	45,613	20,452
Total	$10,464	$65,315	$75,779	$30,334

Table 36

Total Cost of the CO 17

Year	Total Cost of System	System Maintenance Cost
Oct 68-Jun 69	$ 60,518	$ 3,291
Jul 69-Jun 70	88,576	12,972
Jul 70-Jun 71	72,541	27,297
Total	$221,635	$43,560

Assumptions

The CO 17 manages over 99% of the ST/STE at the Sacramento Air Materiel Area. Therefore, not all items managed under this system are associated with the F-100 and F-105 weapon systems. In order to accurately allocate a fair portion of CO 17 costs to the F-100 and F-105 systems, the percentage of ST/STE in both systems was determined. It will be assumed that each of the systems incurs that percentage of the cost of operation of the CO 17.

Table 37

CO 17 ST/STE Breakdown by System (18)

System	ST/STE	Percentage
F-100	21,837	38%
F-105	18,111	32%
Miscellaneous	17,026	30%
Total	56,974	100%

Table 38

CO 17 Cost Allocated by Defense System

	Total		System Maintenance Cost	
Year	F-100	F-105	F-100	F-105
Oct 68-Jun 69	$22,997	$19,366	$ 1,261	$ 1,053
Jul 69-Jun 70	33,569	28,344	4,929	4,151
Jul 70-Jun 71	27,565	23,213	10,373	8,735
Total	$84,221	$70,923	$16,563	$13,939

The Future

The development of the CO 17 system is still not complete because a new developmental phase will begin soon. Consequently, the costs of operating the system will continue to fluctuate. As the system is perfected, operating costs will decline. Since this decline will not occur for several years, it is not possible to predict the point at which operating costs will level out. An educated guess places the figure in the vicinity of $25,000 per year.

APPENDIX E

DUAL BID TEST

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DUAL BID TEST

The data compiled on the dual bid tests conducted by SMAMA are presented in this appendix. In a case where the bidder receiving the contract would not bid without the use of tooling, a bid of the lowest contractor submitting a quote without the use of tooling was inserted in the "without tooling" column. If tooling had not been available, the Government would have awarded to the contractor submitting the lowest bid without tooling. In each of the actions listed below, tooling was available and an award was made to the lowest bid "with tooling."

Table 39

Summary of Dual Bids (15)

	Line Item	Price W/T	Price WO/T	Savings
1	Duct	$ 2,059.00	$ 2,059.00	$ 0
2	Liner	198.00	336.06	138.06
3	Tube	322.20	354.60	32.40
4	Rib	491.05	640.50	149.45
5	Liner	1,635.90	1,635.90	0
6	Door	370.04	539.25	169.21
7	Rib	307.50	589.50	282.00
8	Bracket	693.00	1,110.60	417.60
9	Housing	2,145.00	2,610.30	465.30
10	Fairing	328.57	972.32	643.75
11	Beam	958.56	1,649.88	691.32
12	Doubler	628.91	871.69	242.78
13	Chute	1,252.08	3,776.88	2,524.80
14	Fairing	832.32	832.32	0
15	Door	8,689.44	13,742.80	5,053.36
16	Tray	4,043.45	4,120.50	77.05
17	Plug	167,690.00	175,870.00	8,180.00
18	Aileron	1,042.55	1,642.27	600.28
19	Rib	468.22	793.76	325.54
20	Duct Assy	22,615.95	29,965.39	7,349.44
21	Fairing Assy	28,225.35	33,477.25	5,251.90
	Total	$244,997.69	$277,236.17	$32,238.48

BIOGRAPHICAL SKETCH OF THE AUTHORS

Captain James E. Harnage has seen 15½ years of service, 11 of which were spent in enlisted status. As an enlisted man, he spent three years in Germany with the 585th Tactical Missile Group and eight years with the 1370th Photo Mapping Wing in Florida and in Georgia. In 1966, he entered the Airman Education and Commissioning Program (AECP). Through that program, he gained a Bachelor of Science Degree in Business from Indiana University at Bloomington in 1967. That same program yielded a commission through the Officer Training School in 1967. Since his commissioning, his entire time was spent as Base Procurement Officer at Bitburg AB, Germany and Camp New Amsterdam, Holland. His next assignment will be as a Procurement Officer in the position of Chief Negotiator, R & D Contracts Division under the DCS/Procurement, Aerospace Medical Division (AFSC) at Brooks AFB, Texas.

Captain Michael R. Daly, a 1967 graduate of Officer Training School, is a Procurement Officer. He is a native of Spokane, Washington and is a 1966 graduate of Washington State University where he received a Bachelor of Arts degree in Business Administration. During his six years of Air Force duty, he has served as an Administrative Officer and then cross-trained into the procurement field. He possesses a broad background of experience in the personnel management and contract administration fields. His next assignment is to McClellan AFB, California as a procurement specialist.

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